A.12 Western Spadefoot Toad (*Spea hammondii*)

A.12.1 Legal Status

The western spadefoot toad (*Spea hammondii*) is designated as a state Species of Special Concern (Jennings and Hayes 1994). This species currently does not have any federal listing status. However, because it is associated with vernal pool habitats, it is addressed in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005).

A.12.2 Species Distribution and Status

Range and Status

In North America, the range of the western spadefoot includes portions of California, extending south to Mesa de San Carlos in Baja California Norte, Mexico (Jennings and Hayes 1994, Stebbins 1985, California Academy of Sciences 2008, Museum of Vertebrate Zoology 2008). In California, the range of the western spadefoot includes portions of the Central Valley and bordering foothills, and the Coast Ranges south of Monterey Bay (Figure A.12.1) (Stebbins 2003). The western spadefoot toad has been extirpated throughout most of the lowlands of southern California (Stebbins 1985) and from many historical locations within the Central Valley (Jennings and Hayes 1994, Fisher and Shaffer 1996). Fisher and Shaffer (1996) state that the western spadefoot toad populations have declined severely in the Sacramento Valley, and their density has been reduced in eastern San Joaquin Valley. The numbers in the Coast Ranges have declined more modestly than in the valleys.

This species occurs mostly below 3,000 feet in elevation (Stebbins 1985). The average elevation of sites where the species still occurs is significantly higher than the average elevation for historical sites, suggesting that declines have been more pronounced in lowlands (USFWS 2005).

The population status and trends of the western spadefoot outside of California (i.e., Baja California Norte, Mexico) are not well known. In general, populations of the western spadefoot have reportedly declined, and the species is now extirpated from much of lowland California (Stebbins 2003). Extensive losses have occurred in northern California and in southern portions of the state from the Santa Clara River Valley to south of Los Angeles and Ventura counties (Stebbins 2003).

While western spadefoot toads once ranged throughout the Central Valley (Jennings and Hayes 1994), it is likely that the current land use patterns in the Central Valley portions of Yolo, Solano, Sacramento, and San Joaquin counties (actively cultivated agriculture and increased road density) have significantly decreased habitat suitability. Populations in northern California have generally experienced severe declines (Stebbins 2003, USFWS 2005). The principal factors contributing to the decline of the western spadefoot are loss of habitat due to urban development, conversion of native habitats to agricultural lands, introduction of non-native predators, and pesticide use (Fisher and Shaffer 1996, Hobbs and Mooney 1998, Davidson et al. 2002). Habitat loss and fragmentation result in small, isolated populations, which reduce individual movements and genetic exchange between populations. Reduction in gene flow may result in inbreeding depression and a subsequent reduction in population fitness. Furthermore, many remaining

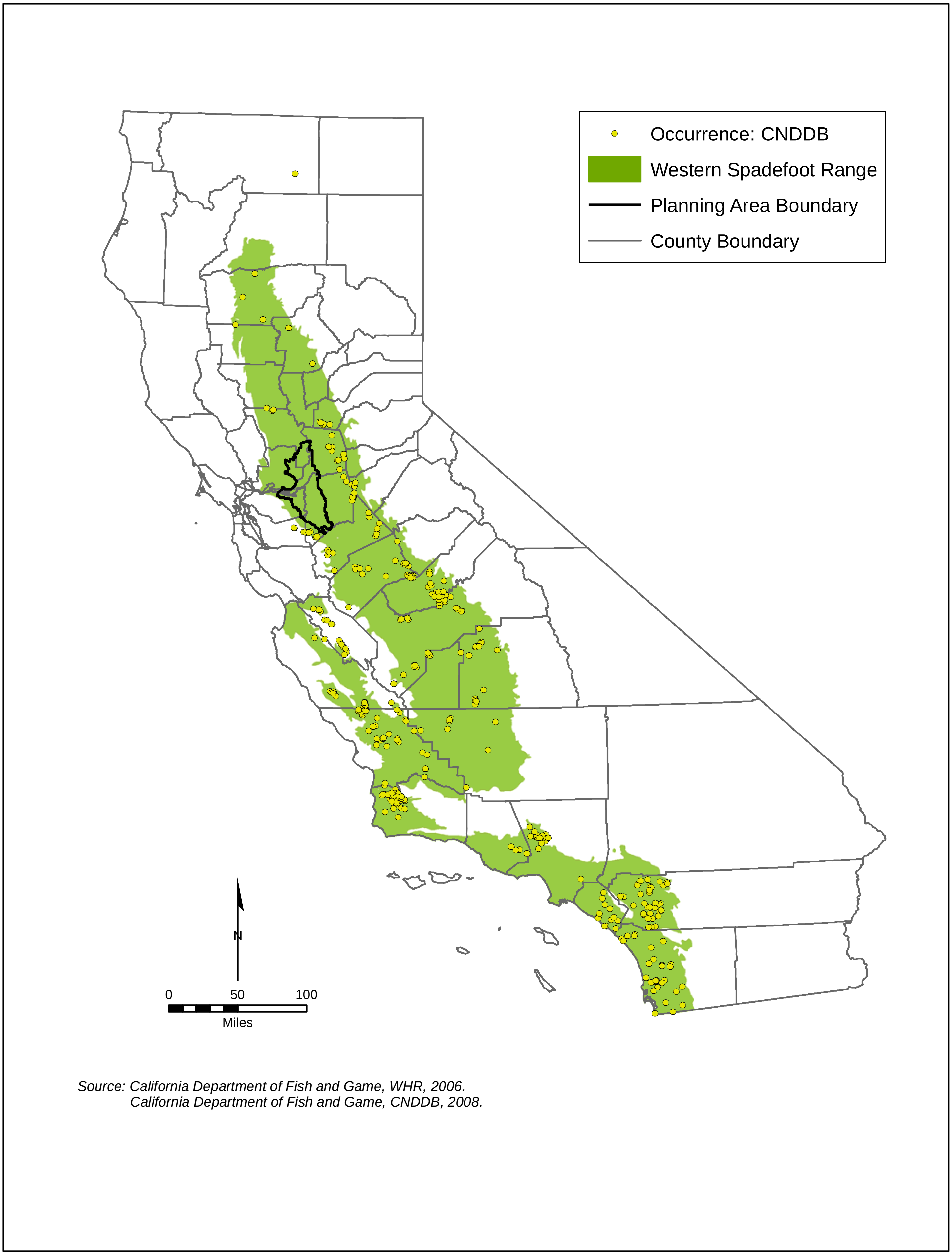

Figure A.12.1. Western Spadefoot Toad Statewide Range and Recorded Occurrences vernal pools and wetlands are suffering from habitat degradation by disking, intensive livestock grazing, off-road vehicle use, and contaminant run-off (Fisher and Shaffer 1996, Hobbs and Mooney 1998, Davidson et al. 2002).

Distribution and Status in the Planning Area

Although the expected range extends through the BDCP Planning Area (Figure A.12.2), no records for western spadefoot toad occur (CNDDB 2008). Potentially suitable habitats occur in remaining uncultivated grasslands near Stone Lakes, east of Interstate 5 in the vicinity of the Cosumnes River Preserve, and along the southwestern edge of the BDCP Planning Area from approximately Brentwood to Tracy.

A.12.3 Habitat Requirements and Special Conditions

Western spadefoot toads require two distinct habitat components to complete their life cycle, and these habitats may need to be in close proximity (USFWS 2005). These components are presence of an aquatic habitat for breeding and a terrestrial habitat for feeding and aestivation. Western spadefoot toads are mostly terrestrial using upland habitats to feed and burrow in for their long dry-season dormancy. Further research is needed to determine the distance this species may travel from aquatic habitats to upland habitats for dispersal and aestivation. Current research on amphibian conservation suggests that average terrestrial habitat use is within 368 m (1,207 feet) of aquatic habitats (Semlitsch and Brodie 2003).

Western spadefoot toads lay their eggs in a variety of permanent and temporary wetlands including rivers, creeks, pools in intermittent streams, vernal pools, and temporary rain pools (CNDDB 2008) as well as stock ponds. This species reproduces in water when temperatures are between 48 °F and 86 °F, and water must be present for more than three weeks for metamorphosis to be completed (Jennings and Hayes 1994). Optimal habitat in vernal pools and other temporary wetlands used for reproduction is free of native and nonnative predators, including fishes, bullfrogs, and crayfishes. Western spadefoot toads may be unable to recruit successfully in the presence of these predators (Jennings and Hayes 1994).

Western spadefoot toads typically inhabit lowland habitats such as washes, floodplains of rivers, alluvial fans, playas, and alkali flats (Stebbins 1985), extending into foothills and mountains to an elevation of 1,360 m (4,462 feet) (Jennings and Hayes 1994). This species may also be found in the foothills and mountains (USFWS 2005). Western spadefoot toads select areas with sandy or gravelly soil with open vegetation and short grasses. Vegetation communities where this species may occur include valley and foothill grasslands, open chaparral, and pine-oak woodlands (USFWS 2005).

During dry periods, individuals typically excavate burrows into the ground at depths up to 3 ft, but they may also occupy burrows constructed by small mammals; whether these are used as short-term refugia during periods of surface activity is unknown (Jennings and Hayes 1994). Adult western spadefoots can consume roughly 11 percent of their body mass at a single feeding (Dimmitt and Ruibal 1980b), and can probably acquire the resources needed for aestivation in just a few weeks (Jennings and Hayes 1994). This aestivation period may continue for nine months at a time (Jennings and Hayes 1994). The skin of western spadefoots is very permeable, enabling them to absorb moisture from surrounding soil. Spadefoots may also be able to retain urea, increasing their internal osmotic pressure, thereby preventing water loss and facilitating water absorption from soils with relatively high moisture tensions (Ruibal et al. 1969, Shoemaker et al. 1969).

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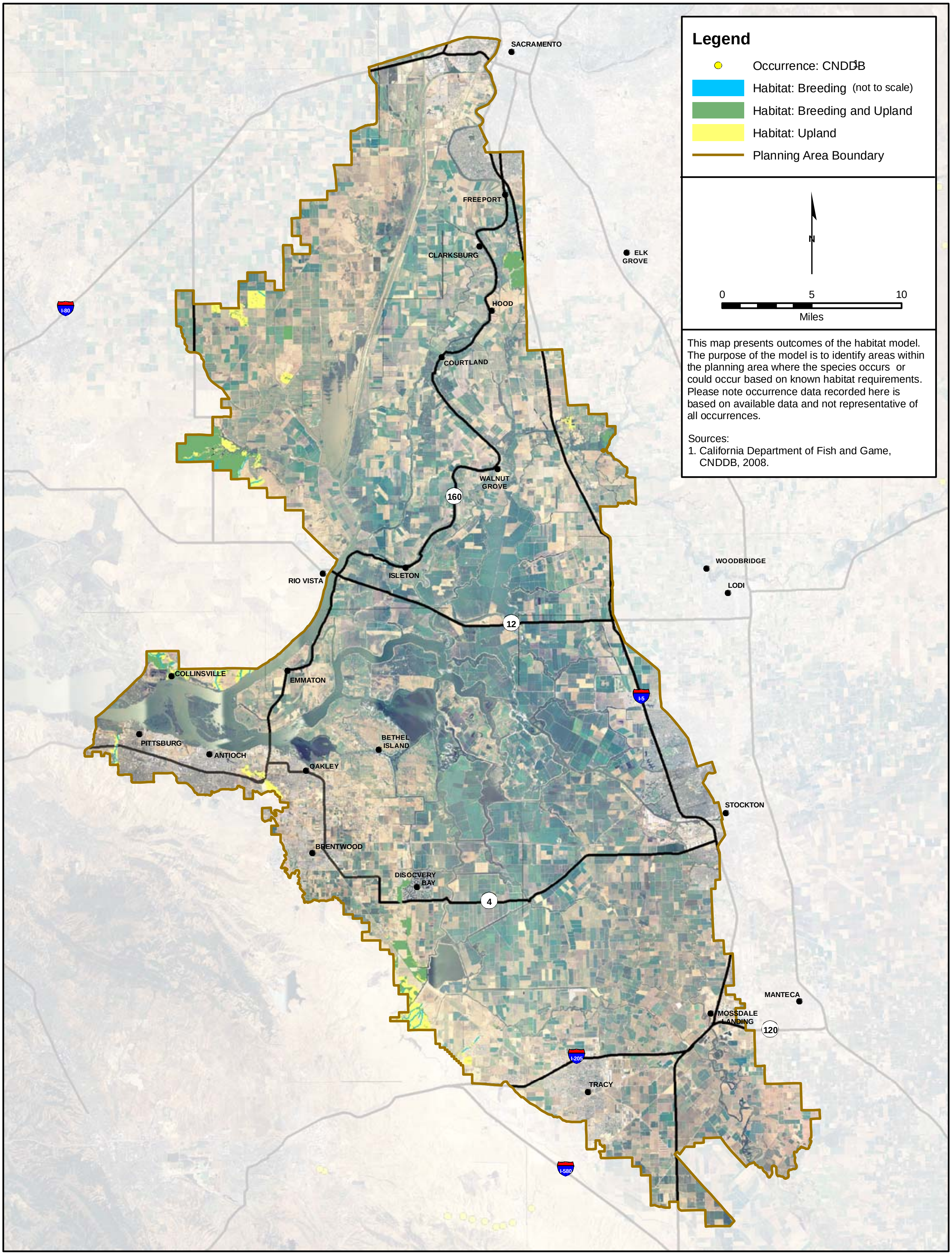

Figure A.12.2 Western Spadefoot Toad Habitat Model and Recorded Occurrences

Natural predators of larval and post-metamorphic western spadefoots include raccoons (*Procyon lotor*), garter snakes (*Thamnophis* spp.), great blue herons (*Ardea alba*), and California tiger salamanders (Childs 1953). There are indications that the presence of introduced predators in breeding pools, such as mosquitofish (*Gambusia affinis*), crayfish (order Decapoda), and bullfrogs (*Rana catesbeiana*) may prevent recruitment (Jennings and Hayes 1994).

Although the degree to which predation affects the population dynamics of western spadefoots is poorly understood, their extended period of aestivation reduces exposure to predators. Spadefoots also produce toxic dermal secretions that deter predation (Duellman and Trueb 1986). Feaver (1971) noted that California tiger salamander larvae preyed on western spadefoot larvae whenever the two species co-occurred and California tiger salamander larvae metamorphosed first. However, Anderson (1968) found that if larvae of the two species are the same size, predation may not occur.

A.12.4 Life History

Description. The western spadefoot toad is a smooth-skinned, grayish-green toad with a gold colored eye. The belly is white and often the back will have orange or red spots. It is usually 1.5 to 2.5 inches long with a characteristic wedge shaped spade on its rear feet.

Seasonal Patterns. Movement patterns and colonization abilities of the adult western spadefoots are not fully understood (Jennings and Hayes 1994). The western spadefoot toad is primarily a terrestrial amphibian and enters the water mainly for reproduction. They typically emerge at night during periods of warm rainfall to forage (Stebbins 1972). Emerging from burrows constructed in loose soil at least three feet deep (Stebbins 1972), they move toward breeding sites in late winter to spring, in response to favorable temperatures and rainfall (Morey and Guinn 1992). The breeding season is brief (Stebbins 2003), sometimes lasting no more than one to two weeks. Following breeding, individuals return to upland habitats, where they spend most of the year aestivating (in a dormant state) in burrows. The western spadefoot may breed in the same ponds as California tiger salamanders (*Ambystoma californiense*), in areas where the two species are sympatric (CNDDB 2008).

Reproduction. Western spadefoot toads breed from January to May. Breeding aggregations can form with over 1,000 individuals, but the aggregations are usually much smaller. These groups are highly vocal, and breeding calls can be heard at great distances. These calls help individuals find each other to form breeding aggregations and suitable breeding sites (Stebbins 1985). Oviposition (egg laying) will not occur until water temperatures reach the critical thermal minimum of 9 °C (48 °F), usually between late February and late May (Jennings and Hayes 1994). Females deposit their eggs in many small irregularly cylindrical clusters of 10 to 42 eggs with an average of 24 (Storer 1925) on stems or pieces of detritus in temporary rain pools, or sometimes in pools of ephemeral stream courses (Storer 1925, Stebbins 1985).

Depending on temperature and availability of food, eggs will hatch within 0.6 to six days after oviposition and larvae can complete development in three to 11 weeks (Jennings and Hayes 1994). If the water temperature is too high, above 21°C (70 °F), hatching success of the eggs may decrease by half possibly due to more favorable temperature for destructive fungus (Storer 1925).

Metamorphosing larvae may leave the water before their tails fully disappear, and sometime the tails are longer than 0.4 inches (Storer 1925). Larvae benefit from longer periods of development with persisting water and adequate temperatures that allow juveniles to reach larger sizes with greater fat reserves at metamorphosis (Morey 1998). After the juveniles emerge from the water, they take refuge in the surrounding area and may remain nearby for several days before dispersing to adjacent upland habitat. These individuals will then construct subterranean burrows and remain dormant for the following eight to nine months during the warmer summer months to avoid desiccation. Individuals may require at least two years reaching sexual maturity (Jennings and Hayes 1994).

Diet. Adult western spadefoot toads feed on a variety of insects, worms, and other invertebrates, including grasshoppers, true bugs, moths, ground beetles, predaceous diving beetles, ladybird beetles, click beetles, flies, ants, and earthworms (Morey and Guinn 1992, USFWS 2005). Tadpoles forage on planktonic organisms, algae, small invertebrates (Bragg 1964), and dead aquatic larvae of amphibians, even their own species.

A.12.5 Threats and Stressors

The main factors contributing to the decline of the western spadefoot toad population include loss of habitat from urban development and conversion of native habitats to agricultural lands, the increase of introduced non-native predators, and stochastic events that particularly impact small, isolated populations (USFWS 2006).

Habitat Loss and Fragmentation. The loss of vernal pool or other seasonal pool habitats due to land conversion is likely the greatest threat to the western spadefoot. More than 80 percent of occupied habitat in southern California and more than 30 percent in northern California have been lost to development or other land uses (Jennings and Hayes 1994). Habitat fragmentation resulting from urban development, agricultural conversion, and road construction also threatens western spadefoot populations. The relationship between habitat fragmentation and the metapopulation structure of the western spadefoot is not entirely understood (Jennings and Hayes 1994); however, ongoing land conversion is undoubtedly resulting in smaller, isolated populations. Direct mortality of toads may occur when toads burrow in actively tilled fields, or are hit by vehicles when dispersing across roads.

Habitat loss and fragmentation produces small populations that are increasingly isolated and limited in space. This reduces the movement of individuals and genetic exchange between populations. Small, isolated populations are highly susceptible to extinction caused by catastrophic or stochastic events. Isolation limits the ability of the population to recolonize areas with suitable habitat where western spadefoot toads may have been present in the past.

Agricultural practices such as disking and intensive livestock grazing and trampling have degraded many remaining vernal pools and wetland habitats, along with off-road vehicle use and contaminated runoff.

Roads can create a barrier to dispersal movements of western spadefoot toads and isolate populations. Contaminants from road materials, leaks, and spills could further degrade aquatic habitats used by this species.

Noise and Vibration. Low frequency noise and vibration in or near habitat for western spadefoot toads may be harmful, even fatal, to this species. Spadefoot toads are extremely sensitive to such stimuli, and it causes them to break dormancy and emerge from their burrows (Dimmitt and Ruibal 1980a). This could result in mortality or reduced productivity if it causes western spadefoot toads to emerge at inappropriate times (USFWS 2005).

Potential anthropogenic sources of such low-frequency noises and vibrations include seismic exploration for natural gas, land grading, or other motorized vehicles or machinery. Artificial irrigation can induce spadefoots to emerge and begin vocalizing in any month (Zeiner et al. 1988).

Non-native Predators. Non-native invasive species are also a threat to the western spadefoot. The predation of spadefoot eggs and larvae by mosquitofish introduced into vernal pools through mosquito abatement programs may threaten some populations (Jennings and Hayes 1994). Bullfrogs, which have been reported to emigrate to some western spadefoot breeding pools, may threaten those populations through predation of spadefoot eggs and larvae. Exotic predators such as mosquitofish may also compete with western spadefoot larvae for limited food resources.

A.12.6 Relevant Conservation Efforts

Jennings and Hayes (1994) state that the most significant data gap related to understanding western spadefoot populations is the relationship between habitat fragmentation and metapopulation structure. Movement patterns and colonization abilities of adult western spadefoots are also not fully understood. Comprehension of the life history and important habitat requirements of the western spadefoot is essential for conservation of the species (Jennings and Hayes 1994). Habitat protection remains the primary strategy for conserving the western spadefoot.

Land acquisition is also an important conservation strategy. Land acquisition is a process in which a public agency or nonprofit land conservation organization purchases all the ownership rights to the land from a willing seller. The property that is to be acquired should contain all the parameters mentioned above. An important quality of the acquired property should be the allowance of genetic flow between populations via wildlife corridors. However, since movement patterns and colonization abilities of adult spadefoots are not fully understood, it is unknown how effective movement corridors between populations will affect the species.

The CALFED Bay-Delta Ecosystem Restoration Program Plan’s Multi-Species Conservation Strategy designates the western spadefoot toad as “Maintain” (CALFED Bay-Delta Program 2000). This means that CALFED will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects to the species created by CALFED restoration actions.

A.12.7 Species Habitat Suitability Model

Habitat: Western spadefoot toads require two distinct habitat components to complete their life cycle, aquatic habitat for breeding and a terrestrial habitat for feeding and aestivation (Jennings and Hayes 1994, USFWS 2005). Aquatic habitats include a variety of permanent and temporary wetlands including pools in streams, ponds (including stock ponds), and vernal pools. Terrestrial habitat includes grasslands and other uncultivated upland habitats. Vernal pool grasslands are considered the primary habitat type for this species, which supports both aquatic breeding and upland aestivation habitat.

Habitat for western spadefoot is defined as follows:

Breeding and Upland Habitat:

- Vernal pool dominated grasslands (excluding theYolo Bypass flood inundation area).

Other Breeding habitat:

- Segments of intermittent streams within or adjacent to: vernal pool dominated grasslands, grasslands, non-tidal freshwater perennial emergent wetland that are adjoining or within grasslands or vernal pool dominated grasslands;
- non-tidal freshwater perennial emergent wetland that are adjoining or within grasslands or vernal pool dominated grasslands.

Other Upland Habitat

- All grassland types that are within 1,200 feet of and adjacent to vernal pool dominated grasslands, intermittent streams, or non-tidal freshwater perennial emergent wetland.

The Yolo Bypass is not considered to support habitat because of frequent recurring flooding that would inundate aestivation habitat, thus precluding occupancy. Central Delta islands are also not considered to support habitat because they are highly disturbed environments and are fragmented from other habitat areas by large channels. Additionally, patches of suitable land cover types less than 100 acres that were isolated from other patches of habitat are not considered habitat in the model.

Assumptions: Cultivated habitats do not provide terrestrial habitat for western spadefoot toads because cultivation disrupts aestivation. Proximity of aquatic breeding habitat and terrestrial habitat is an important element of spadefoot life history. While additional information is needed, current research suggests that average terrestrial habitat use is within 368 meters (1,207 feet) of aquatic habitat (Semlitsch and Brodie 2003). Because information on stock ponds and possibly other potentially suitable aquatic habitats is not available for the planning area, the model may underestimate the extent of habitat. However, there are no reported occurrences of western spadefoot toad from the planning area. The nearest reported occurrences are in the foothill grasslands west of Interstate 505 and south of Interstate 205 southwest of the planning area. While grassland habitats along the western edge of the planning area, particularly south of Brentwood, and the eastern edge of the planning area in the vicinity of Stone Lakes have a reasonable potential to support this species, the more isolated grassland habitats in the Central Delta are considered to have substantially less potential to support this species.

Areas subject to periodic flooding (e.g., Yolo Bypass) are unlikely to support western spadefoot due to recurring inundation of aestivation habitat.

Western spadefoot requires relatively large grassland landscapes and is unlikely to occur in fragmented or isolated patches of otherwise suitable habitat. However, data are lacking on a minimum patch size. A 100-acre minimum was selected to exclude very small and isolated patches. However, the minimum patch size is likely larger than 100 acres and thus the model may overestimate habitat based on this parameter.

A.12.8 Recovery Goals

The western spadefoot was included for coverage in the “Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon” (USFWS 2005). The USFWS’s stated goals for the western spadefoot and 12 other species of special concern covered under the Recovery Plan are to achieve and protect in perpetuity self-sustaining populations of each species and ensure the species’ long-term conservation. The primary focus of the Recovery Plan is protection of vernal pool habitat—in the largest blocks possible—from loss, fragmentation, degradation, and incompatible uses (USFWS 2005). For the western spadefoot, the Recovery Plan calls for:

- Conducting research on juvenile and adult dispersal to and from breeding locations,
- Conducting research on the effects of habitat management practices on the western spadefoot and their habitat in order to determine the limiting factors with respect to determining minimum reserve sizes,
- Studying the impacts of low-frequency noises and vibrations, and
- Determining the influence of non-native aquatic vertebrate predators (e.g., bullfrogs and mosquitofish) on population dynamics.

The overall goals of the Vernal Pool Recovery Plan, are to "achieve and protect in perpetuity self-sustaining populations throughout the full ecological, geographical, and genetic range of each listed species by ameliorating or eliminating the threats that caused the species to be listed" (USFWS 2005). Specifically for western spadefoot toad, the goal is to ensure long-term conservation.

The Vernal Pool Recovery Plan concluded that:

> "Based on calculations from upland habitat use data analyzed by Semlitsch and Brodie (2003), a minimum conservation area to preserve the ecological processes required for the conservation of amphibians may fall within a distance of approximately 368 meters (1,207 feet) from suitable breeding wetlands. Given a square preserve surrounding a single breeding pond, this estimate would suggest a minimum preserve size of approximately 54.2 hectares (134 acres). In any given western spadefoot toad metapopulation, we expect that some subpopulations will disappear, but the habitat they occupied will eventually be recolonized if it remains acceptable. To enable natural recolonization of unoccupied habitat, and to allow for gene flow that is vital for preventing inbreeding, opportunities for dispersal and interbreeding among subpopulations of the western spadefoot toad must be maintained. Where possible, habitat corridors between breeding sites should be protected and maintained."

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